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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/681,030
Filing Date: October 07, 2003
Appellant(s): BORODOVSKY, YAN

John F. Conroy
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed December 4, 2007, appealing from the Office action mailed 03/09/2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

Substantially agree. The appellant's statement of the grounds of rejection to be reviewed on appeal is correct. Note that the appellant has not contested the 35 U. S. C. 103 (a) rejections of claims 14-15, 18, and 35, in the Supplemental Brief on Appeal.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,415,835	Brueck et al.	05-1995

2002/0078427	Palmer et al.	06-2002

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 11, and 37, are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

3. Claim 11, at line 14, and claim 37, at line 13, recite the limitation “the formerly periodic pattern”. There is insufficient antecedent basis for this limitation in the claims.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 11-13, 16-17, and 36-37, are rejected under 35 U.S.C. 102(b) as being anticipated by U. S. Patent No. 5,415,835 (Brueck et al., hereinafter referred to as Brueck).

Brueck, in the abstract, in col 2, lines 38-61, in col 6, lines 30-41, discloses irradiating the photoresist layer by interferometric lithography to form a line and space pattern that has a first line width and a pitch of about half the wavelength (λ/2) on the photoresist layer (first photoresist), exposing the resulting line and space pattern to a second exposure means (masked exposure) to form features that have a second line width, wherein the second line width is greater than the first line width (see figures 16 thru 19), and the pitch of the feature formed is about twice the pitch of the interference pattern (line and space pattern formed by interferometric lithography). Brueck, in col 4, lines 31-40, discloses that after the subsequent pattern is developed, a second photoresist is coated over the developed photoresist layer, followed by another exposure process to form a third pattern (third pattern width), the third pattern is greater than the first pattern width (see figures 16, 17, and 8). Brueck, in col 4, lines 53-67, in col 5, lines 1-5, that the pattern (developed second photoresist pattern, and the pattern from the first photoresist used as a guide) is translated into a grating structure via etching into the support structure (silicon substrate, line and space pattern) (claims 11-13, and 36-37). Brueck, in col 2, lines 62-68, in col 3, lines 1-2, in col 4, lines 30-41, discloses that the alignment system is employed that aligns the second photoresist layer (third pattern) to the feature and the interference pattern (claims 16-17).

6. Claims 30-34, are rejected under 35 U.S.C. 102(b) as being anticipated by U. S. Patent Application Publication No. 2002/0078427 (Palmer et al., hereinafter referred to as Palmer).

Palmer, in the abstract, in [0001], [0005], [0006], [0007], [0024], discloses providing a theoretical mask layout data, creating a mask design layout to form a contoured data set (line and space pattern for integrated circuit etc), subtracting the theoretical mask data set from the contoured data set to obtain a desired mask layout (remainder layout forms the print mask) (claims 30, and 33). Palmer, in [0020], discloses that the aligning the original (theoretical) mask layout (design layout) with the contoured mask data (claim 31). Palmer, in [0024], and in claims 1, 5, and 6, discloses generating a data (remainder layout data) that can be implemented to form a mask (claim 32). Palmer, in [0022], and [0023], discloses that the desired layout (adjusted by Boolean operation) can be resized (reduced in size or overstated in size) (claim 34).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 14, and 15, are rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 5,415,835 (Brueck et al., hereinafter referred to as Brueck) in view of U. S. Patent No. 4,517,280 (Okamoto et al, hereinafter referred to as Okamoto).

Brueck, is discussed in paragraph no. 5.

The difference between the claims and Brueck is that Brueck does not disclose that the second photoresist is chemically distinct from the first photoresist (claim 14). Brueck does not disclose a third barrier layer residing between the first and second photoresists, that has high absorption of light to expose the first photoresist and chemical structure that prevents the mixing of the first and second photoresist (claim 15).

Okamoto, in col 3, lines 10-64, discloses forming a first photoresist pattern (from a first photoresist material), after the developing process, a second photoresist material different chemically from the first photoresist material is formed on the first photoresist pattern, enabling the presence of a barrier layer between the first photoresist material pattern and the second photoresist layer (barrier layer forms on the surface of the first photoresist pattern due to exposure to native oxides, developing solutions etc, and has high absorption of light), and preventing the mixing of the first photoresist pattern material and the second photoresist material layer. Okamoto, col 3, lines 26-44, discloses that the mask (barrier layer) placed in contact with the first and second photoresist also prevents exposure to the fist photoresist.

Therefore, it would be obvious to a skilled artisan to modify Brueck by employing the method of Okamoto to coat the substrate with two different resist materials because Okamoto, in col 3, lines 25-33, discloses that using a second different photoresist material on the first photoresist pattern enables the removal of only that part of the second photoresist where the diffraction grating is to be formed while leaving the other part in tact, and in col 4, lines 1-5, discloses that also the choice of a different second photoresist material can also be tailored to prevent the grating pattern of the first photoresist from being thermally deformed during subsequent processing steps.

9. Claim 18, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 5,415,835 (Brueck et al., hereinafter referred to as Brueck) in view of U. S.

Patent Application Publication No. 2002/0078427 (Palmer et al., hereinafter referred to as Palmer).

Brueck is discussed in paragraph no. 5.

The difference between the claims and Brueck is that Brueck does not disclose that the print mask is generated by subtracting the final design layout from the interference pattern (claim 18).

Palmer in [0006], [0007], [0022], [0023], and in figure 6, discloses that a subtraction of the bounded contour (final design layout) and the initial input (interference pattern) is performed to obtain the desired mask layout.

Therefore, it would be obvious to a skilled artisan to modify Brueck by performing a subtraction to the initial input mask data and the bounded data set as suggested by Palmer because Palmer in [0023], discloses that performing a Boolean operation enables the designer to adjust the original layout or adjust the proximity correction attributable to a particular feature that is otherwise overstated in size by too large of a degree or reduced in size or completely omitted.

10. Claim 35, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent Application Publication No. 2002/0078427 (Palmer et al., hereinafter referred to as Palmer) in view of U. S. Patent No. 5,415,835 (Brueck et al., hereinafter referred to as Brueck).

Palmer is discussed in paragraph no. 3.

The difference between the claims and Palmer is that Palmer does not disclose that the pattern layout is produced by interference lithography.

Brueck, in col 2, lines 38-55, discloses that pattern layout is imparted using interference lithography.

Therefore, it would be obvious to a skilled artisan to modify Palmer by employing the interferometric lithography suggested by Brueck to produce a pattern layout because Brueck, in col 2, lines 48-56, and in col 3, lines 20-27, discloses that using interferometric lithography enables the production of the extreme submicrometer structures and flexible interconnect technology needed to produce useful structures.

(10) Response to Argument

Ground 1.

Appellant argues that antecedent basis has been established for the recitation of “the formerly periodic pattern” in claims 11, and 37.

Claims 11, and 37, recite forming a periodic pattern of lines and spaces on a first photoresist. The claims further recite “exposing a portion of at least one line to radiation to break continuity of the line and periodicity of the periodic pattern". Claim 11, at line 13, and claim 37, at line 13, recite “to form a feature over the formerly periodic pattern of the first photoresist”. The first pattern formed is the only pattern that is periodic, and in line 6 of claims 11, and 37 was already referred to as the periodic pattern. Also, the second exposure only causes irregularity to one line or to a portion, and does not induce irregularity and/or non-periodicity to all the lines and spaces i.e., the first pattern is already periodic, and there is no other pattern formed that is also periodic and therefore does not necessitate the reference of "the formerly periodic pattern". Further more, the periodic pattern of the first photoresist has already been referred to as “the periodic pattern", and therefore the reference "the formerly periodic pattern" lacks antecedent basis.

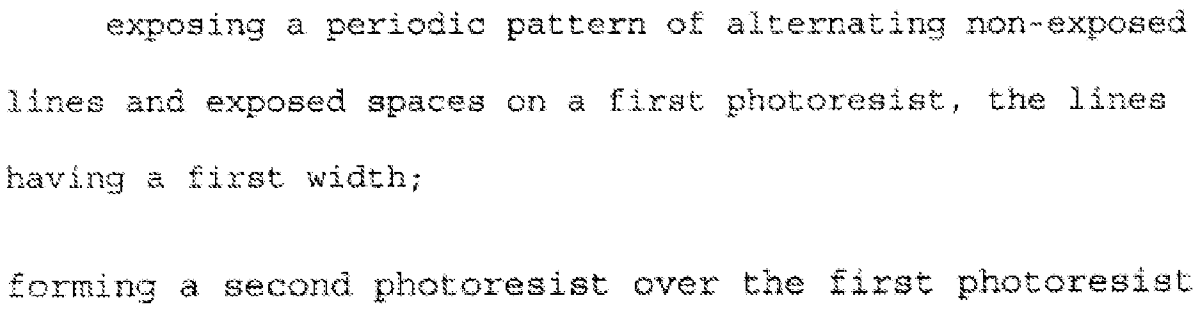
Ground 2.

Claim 11 and 37.

A) Appellant argues that there is no teaching that the original layer of photoresist remains on Brueck's substrate so that Brueck's second photoresist layer can be formed over it as recited.

The claim as recited, recites that the second photoresist is formed over the first photoresist. The first photoresist refers to a first photoresist that has been already patterned i.e., a line and space periodic pattern has been formed. See below.

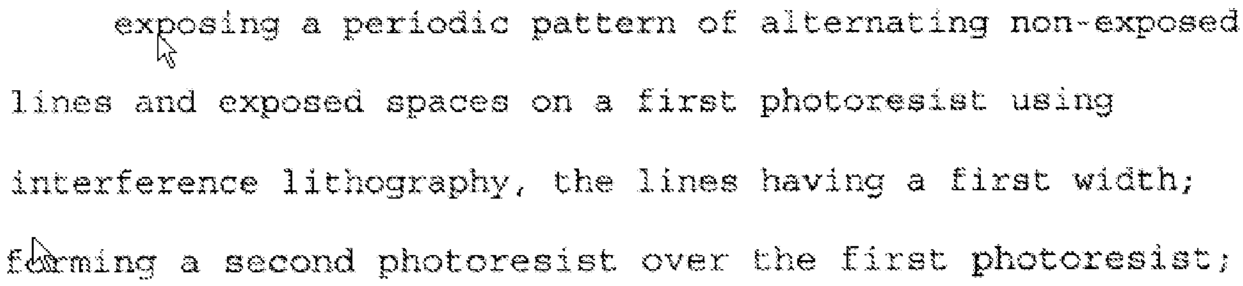
Claim 11, lines 2-4, and line 11,



exposing a periodic pattern of alternating non-exposed lines and exposed spaces on a first photoresist, the lines having a first width;

forming a second photoresist over the first photoresist;

Claim 37, lines 2-4, and line 11,

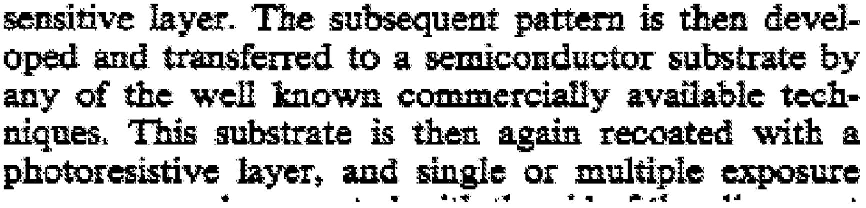


exposing a periodic pattern of alternating non-exposed lines and exposed spaces on a first photoresist using interference lithography, the lines having a first width;

forming a second photoresist over the first photoresist;

i.e., the second photoresist is formed on the line and space pattern of the first photoresist.

Brueck, teaches performing a first exposure (line and space pattern formed as a result of exposure) followed by another exposure on the same photosensitive layer. After the exposures, the exposed photosensitive layer is then developed to form a pattern, and the pattern is transferred to the semiconductor substrate, and then recoated with a photoresistive layer. In order to form a pattern, the exposed photosensitive layer must be developed so that for a positive (photosensitive or photoresist) layer the exposed portions can be dissolved away, and the unexposed portions of the photosensitive layer will be the pattern formed. See below.

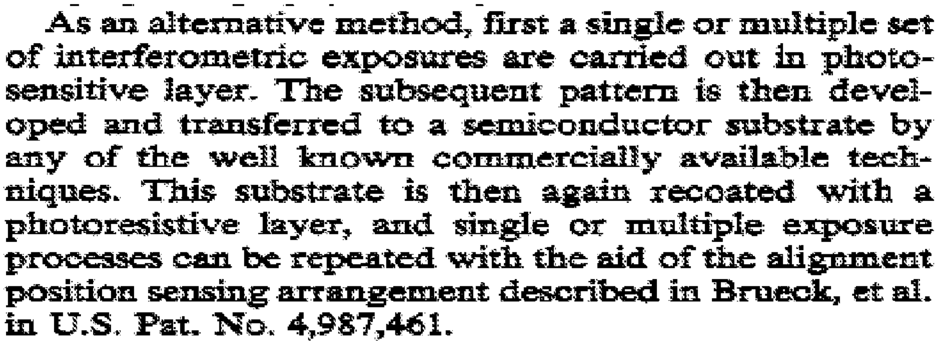


sensitive layer. The subsequent pattern is then developed and transferred to a semiconductor substrate by any of the well known commercially available techniques. This substrate is then again recoated with a photoresistive layer, and single or multiple exposure

In order to transfer a pattern that is formed after a development process, the pattern (that portions that was not developed away) will remain on the underlying substrate (or underlying substrate or layers or stack) to mask the underlying portions, and the exposed portions that no longer has the phosensitive mask will be exposed to etching means so that these exposed portions can be etched, thus transferring the pattern to the underlying substrate only in the exposed, unmasked portions. After such a transfer, the substrate (that has the photosensitive pattern still on it) is recoated with a photoresistive layer. Brueck does not mention or suggest that after the transferring of the pattern, a stripping process is performed to remove the existing photosensitive layer pattern on the semiconductor substrate. Therefore, it is taken at face value that since no stripping or removal process is suggested or mentioned, that the substrate with the photosensitive pattern is recoated with another photoresistive layer.

B) Appellant argues that there is no support for the contention that Brueck does not strip a first photoresist prior to applying a second photoresist, and that Brueck's description that the substrate is recoated implies the opposite.

Brueck, performs multiple exposure (first and second at least) on a photosensitive layer and clearly mentions developing the photosensitive layer i.e., to form a pattern. A developing process does not remove the entire photosensitive layer. Brueck also mentions that the pattern formed due to development is transferred to the semiconductor substrate. See below.



As an alternative method, first a single or multiple set of interferometric exposures are carried out in photosensitive layer. The subsequent pattern is then developed and transferred to a semiconductor substrate by any of the well known commercially available techniques. This substrate is then again recoated with a photoresistive layer, and single or multiple exposure processes can be repeated with the aid of the alignment position sensing arrangement described in Brueck, et al. in U.S. Pat. No. 4,987,461.

A transfer process, after development is neither a stripping, nor a removal process; a transfer process requires the presence of the photosensitive mask throughout the transfer process i.e., an etching process, so that the unmasked portions of the underlying semiconductor substrate can etched through. After such a transfer process, Brueck does not mention or suggest anywhere that a stripping process or removal process is performed. Therefore, it is assumed that the substrate being recoated is the substrate with the unstripped photosensitive mask being recoated with a photoresist layer. Brueck's mentioning of the "by any of the well known commercially available techniques" is in reference to the transferring of the pattern i.e., transfer of the pattern via etching through the portions of the substrate without etching the photoresist mask using ion beam etching, or sputter etching or plasma etching techniques. Additionally, Brueck mentions that "this substrate is then again recoated". It does not imply an already patterned and stripped substrate, it implies that substrate with the photosensitive mask that has been through a transferring process wherein the unmasked portions have been etched.

C) Appellant argues that Brueck's usage of the term "substrate" excludes the first photosensitive layer in the immediately preceding sentence, and that the term "recoat" implies that is the substrate-absent the first photosensitive layer-.

Brueck mentions the substrate is then again recoated. However, in the immediately preceding sentence it is a semiconductor substrate that is patterned. To assume that the substrate is that which is excluded from the presence of the photosensitive layer is to also suggest that the substrate has no pattern in it. The immediately preceding sentence clearly mentions that a pattern is transferred to the semiconductor substrate; and the immediately following sentence is that "this substrate is then again recoated", i.e., a substrate that has undergone a pattern transfer process, not a stripping process or a resist removal process nor a residue removal process. There is no mention anywhere of any processes being performed other than a pattern transfer process i.e., etching the exposed portions that is unmasked by using the existing photosensitive mask as the mask to etch the unmasked portions of the semiconductor substrate.

D) Appellant argues that Brueck appears to remove the first photoresist layer so that the substrate can be recoated.

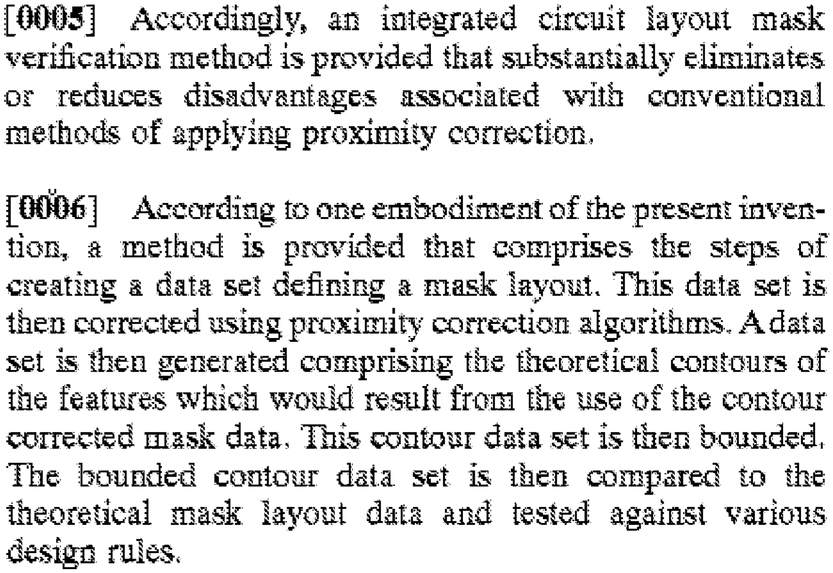
Brueck, as mentioned in the above arguments, does not suggest or teach any removal or stripping processes. Brueck only mentions after developing to form a pattern of the photosensitive layer, that a patterning process is performed to transfer the pattern to the semiconductor substrate i.e., using the photosensitive mask to etch through the substrate portions that are not masked by the photosensitive mask. After performing the patterning process, there is no mention of any removal or stripping of the still existing unetched photosensitive mask portions present on the semiconductor substrate. Brueck teaches that "this substrate is then again recoated". Therefore, Brueck does no appear to remove the first photoresist layer so that the substrate can be recoated.

Ground 3.

Claim 30.

A) Appellant argues that Palmer’s final bounded contour data set is not a layout at all, much less either a design layout or a pattern layout.

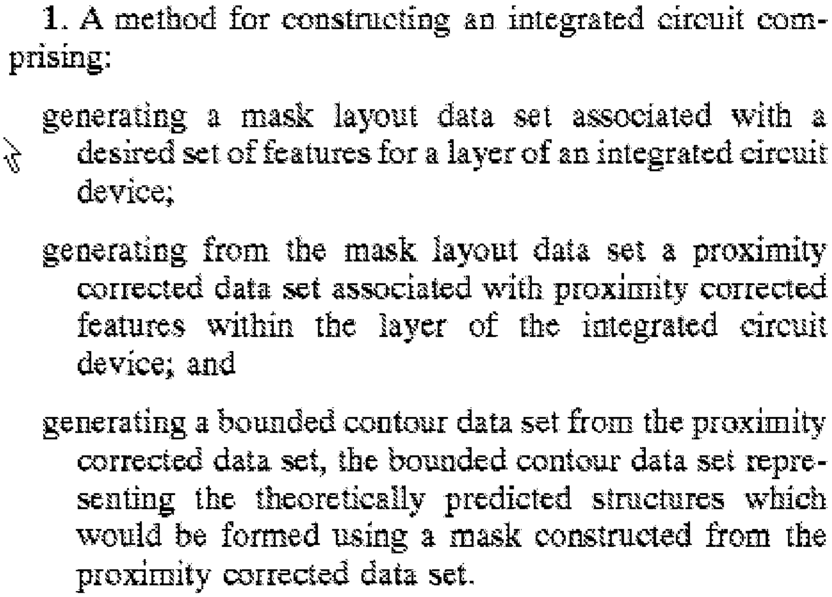
Palmer, discloses the bounded contour data and discloses that the data set is that of features, and that the bounded contour data set is then compared to the theoretical mask layout of an integrated circuit. The theoretical data set of the mask comprises lines and spaces i.e., a pattern layout or a design layout, and if it is used to compare to that of the generated bounded contour data set, it has to be that of features such as lines and spaces of pattern. See below



[0005] Accordingly, an integrated circuit layout mask verification method is provided that substantially eliminates or reduces disadvantages associated with conventional methods of applying proximity correction.

[0006] According to one embodiment of the present invention, a method is provided that comprises the steps of creating a data set defining a mask layout. This data set is then corrected using proximity correction algorithms. A data set is then generated comprising the theoretical contours of the features which would result from the use of the contour corrected mask data. This contour data set is then bounded. The bounded contour data set is then compared to the theoretical mask layout data and tested against various design rules.

Additionally, Palmer discloses that bounded contour data set represent the theoretically predicted structures, and that bounded contour data set are generated from the proximity corrected data set, wherein the proximity corrected data set is that associated with proximity corrected features i.e., lines and spaces are included. See below.



1. A method for constructing an integrated circuit comprising:

generating a mask layout data set associated with a desired set of features for a layer of an integrated circuit device;

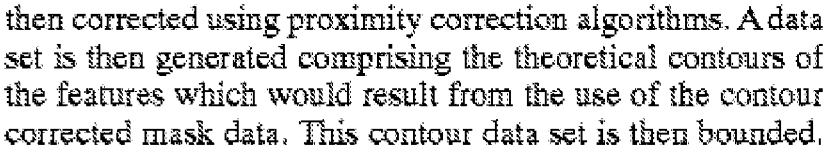
generating from the mask layout data set a proximity corrected data set associated with proximity corrected features within the layer of the integrated circuit device; and

generating a bounded contour data set from the proximity corrected data set, the bounded contour data set representing the theoretically predicted structures which would be formed using a mask constructed from the proximity corrected data set.

Therefore, the final bounded contour data set is a layout of a mask i.e., a pattern layout.

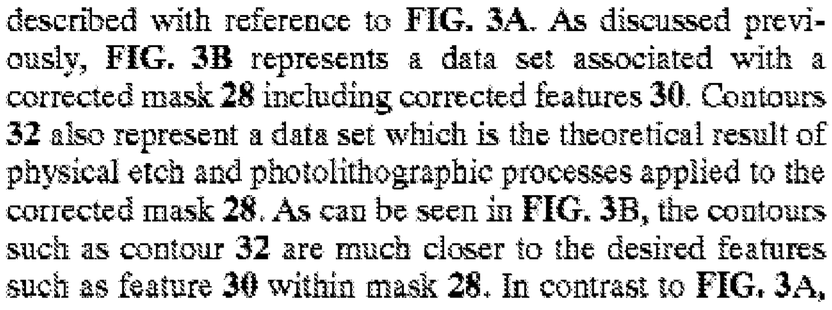
B) Appellant argues that the theoretical contours are not a layout.

As discussed above, Palmer, in paragraph [0006], see below,

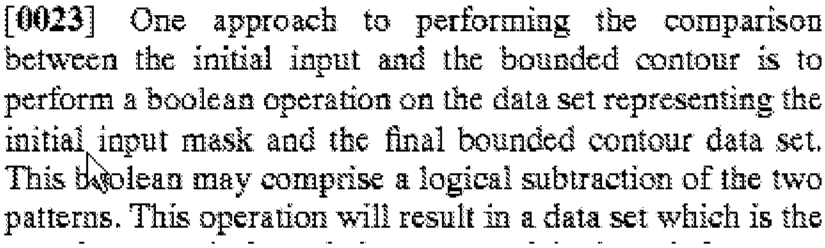


then corrected using proximity correction algorithms. A data set is then generated comprising the theoretical contours of the features which would result from the use of the contour corrected mask data. This contour data set is then bounded,

discloses that the theoretical contours are that of the features i.e., line and space patterns that are resulted from the use of the contour corrected mask data i.e., it is a layout. Additionally, Palmer, in [0019], discloses, see below,



described with reference to **FIG. 3A**. As discussed previously, **FIG. 3B** represents a data set associated with a corrected mask **28** including corrected features **30**. Contours **32** also represent a data set which is the theoretical result of physical etch and photolithographic processes applied to the corrected mask **28**. As can be seen in **FIG. 3B**, the contours such as contour **32** are much closer to the desired features such as feature **30** within mask **28**. In contrast to **FIG. 3A**, That the contour data set (theoretical) is a result of the processes applied to the corrected mask, and that the contours are much close to the desired features such as feature within mask i.e., the theoretical contour data set is a layout of features (line and space pattern). Additionally, in paragraph [0023], see below,



[0023] One approach to performing the comparison between the initial input and the bounded contour is to perform a boolean operation on the data set representing the initial input mask and the final bounded contour data set. This boolean may comprise a logical subtraction of the two patterns. This operation will result in a data set which is the

Palmer refers to a) the initial input mask data and b) the final bounded contour data set, as two patterns i.e., the contour data set (final) is a layout of lines and spaces.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

dcd

/Daborah Chacko-Davis/

Examiner, Art Unit 1795

Conferees:

/Mark F. Huff/
Supervisory Patent Examiner, Art Unit 1795

/Gregory L Mills/
Supervisory Patent Examiner, Art Unit 1700